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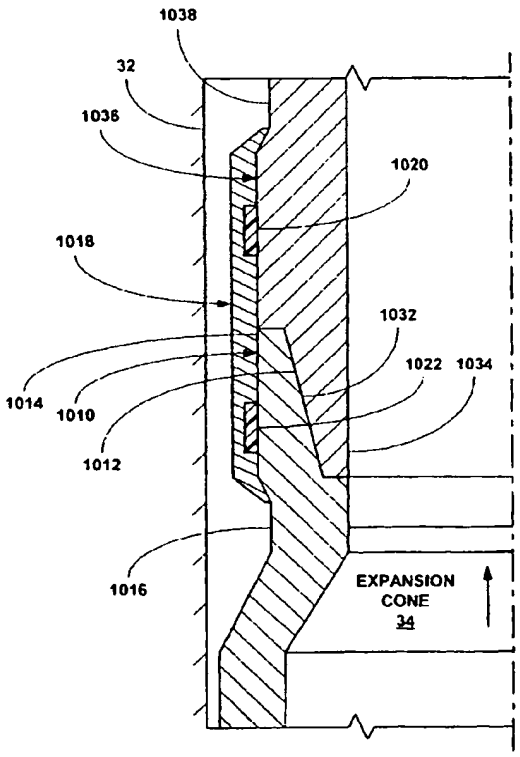
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,

[Continued on next page]

(54) Title: PROTECTIVE SLEEVE FOR THREADED CONNECTIONS FOR EXPANDABLE LINER HANGER

(57) Abstract: A tubular sleeve (1018) is coupled to and overlaps the threaded connection (1012, 1032) between a pair of adjacent tubular members (1016, 1038).



GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

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— *of inventorship (Rule 4.17(iv)) for US only*

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/06544

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : E21B 19/16
US CL : 166/380, 85.3, 309, 387, 72, 73; 285/382.7, 398

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 166/380, 85.3, 309, 387, 72, 73, 187, 195, 206, 207, 212, 216, 217; 285/382.7, 398, 55, 388.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,405,761 B1 (SHIMIZU et al) 18 June 2002, see entire document	1-120
A	US 5,971,443 A (NOEL et al) 26 October 1999, see entire document	1-120
A	US 5,309,621 A (O'DONNELL et al) 10 May 1994, see entire document	1-120
A	US 3,997,193 A (TSUDA et al) 14 December 1976, see entire document	1-120
A	US 3,989,280 A (SCHWARZ) 02 November 1976, see entire document	1-120
A	US 3,834,742 A (MCPHILLIPS) 10 September 1974, see entire document	1-120
A	US 3,579,805 A (KAST) 25 May 1971, see entire document	1-120
A	US 2,647,847 A (BLACK et al) 04 August 1953, see entire document	1-120
X	US 4,693,498 A (BLAUGH et al) 15 september 1987, see Fig. 2a and 2b.	54

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2003 (30.07.2003)	09 JUN 2004
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer Roger J. Schoeppel Telephone No. (703) 306-4180

Form PCT/ISA/210 (second sheet) (July 1998)

PCT/US03/06544

INTERNATIONAL SEARCH REPORT

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,275,556 B1 (KINNEY et al) 14 August 2001. see Fig. 3	54

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/06544

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:
The independent claims of the Group I inventions all require the radial-plastic deformation of a jointed tubular connection whereas the independent claims of Group II inventions make no such requirement. Group III claims differ in that the independent claims require the radial-plastic deformation of the tubular connections in a method and/or apparatus used in extracting geothermal energy from a geothermal well whereas the Group IV invention makes no such deformation requirement. The Group I and II claims further differ in requiring tubular connections involving internal or external tubular threads with corresponding internal or external threaded sleeve ends. The independent claims of Groups III and IV all require their use as a liner in the completion of a well to be used in extracting geothermal energy.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1-53, drawn to a "Method."

Group II, claim(s) 54-110, drawn to an "Apparatus."

Group III, claim(s) 111-119, drawn to a "Method and Apparatus for Extracting Geothermal Energy."

Group IV, claim(s) 120, drawn to an "Apparatus for Extracting Geothermal Energy."

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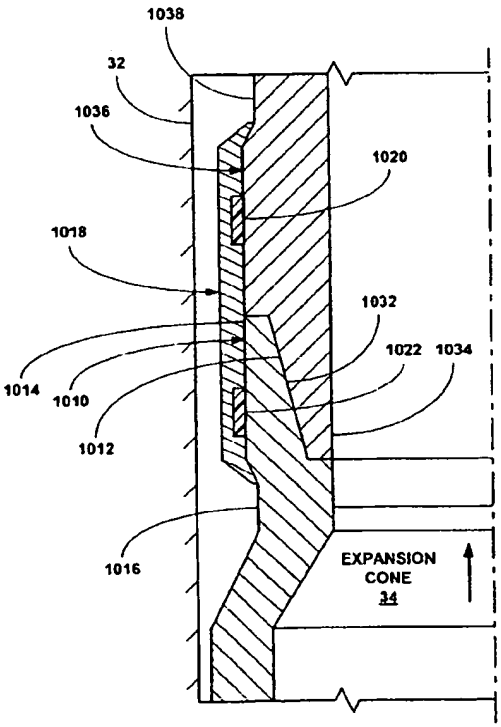

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(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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— *with amended claims*

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Date of publication of the amended claims: 29 December 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

AMENDED CLAIMS
[received by the International Bureau on 06 August 2004 (06.08.04);
new claims 121-153 added; remaining claims unchanged (7 pages)]

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member.

120. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing string positioned within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

121. A method of radially expanding and plastically deforming a first tubular member and a second tubular member, comprising:

coupling an end of the first tubular member with an end of a tubular sleeve;

coupling an end of the second tubular member with another end of the tubular sleeve;

placing the tubular members within a wellbore; and

displacing an expansion device through the interiors of the first and second tubular members to radially expand and plastically deform portions of the first and second tubular members.

122. The method of claim 121, wherein the ends of the first and second tubular members are received within the ends of the tubular sleeve.

123. The method of claim 121, wherein the ends of the first and second tubular members receive the ends of the tubular sleeve.

124. The method of claim 121, wherein, before, during, and after the radial expansion of the portions of the first and second tubular members, a fluid tight seal is provided by the interface between the tubular sleeve and the ends of the first and second tubular members.

125. A method of radially expanding and plastically deforming a first tubular member and a second tubular member, comprising:

coupling an end of the first tubular member with an end of a tubular sleeve;

coupling an end of the second tubular member with another end of the tubular sleeve; and

displacing an expansion device through the interiors of the first and second tubular members to radially expand and plastically deform portions of the first and second tubular members;

wherein, before, during, and after the radial expansion of the portions of the first and second tubular members, a fluid tight seal is provided by the interface between the tubular sleeve and the ends of the first and second tubular members.

126. The method of claim 125, wherein the ends of the first and second tubular members are received within the ends of the tubular sleeve.

127. The method of claim 125, wherein the ends of the first and second tubular members receive the ends of the tubular sleeve.

128. The method of claim 125, further comprising:

placing the tubular members within a wellbore; and

then displacing an expansion device through the interiors of the first and second tubular members to radially expand and plastically deform portions of the first and second tubular members.

129. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the end portion of the first tubular member is in circumferential compression; and

wherein the end portion of the second tubular member is in circumferential compression.

130. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the end portion of the first tubular member is in circumferential tension; and

wherein the end portion of the second tubular member is in circumferential tension.

131. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the tubular sleeve comprises an internal flange.

132. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the tubular sleeve comprises an external flange.

133. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the tubular sleeve further comprises one or more sealing members for sealing the interface between the tubular sleeve and at least one of the tubular members.

134. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion;

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; and

a retaining ring positioned between the end of the first tubular member and the end of the tubular sleeve.

135. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion;

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; and

a retaining ring positioned between the end of the first tubular member and the other end of the tubular sleeve.

136. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the end of the tubular sleeve is deformed onto the end of the first tubular member.

137. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the other end of the tubular sleeve is deformed onto the end of the second tubular member.

138. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion;

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; and

a retaining ring coupled to the end of the first tubular member for retaining the tubular sleeve onto the end of the first tubular member.

139. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion;

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; and

a retaining ring coupled to the end of the second tubular member for retaining the other end of the tubular sleeve onto the end of the second tubular member.

140. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion;

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; and

a locking ring for coupling the end of the first tubular member to the end of the tubular sleeve.

141. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion;

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; and

a locking ring for coupling the end of the second tubular member to the other end of the tubular sleeve.

142. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion;

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; and

a structure for receiving the first and second tubular members and the tubular sleeve;

wherein the tubular sleeve contacts the interior surface of the structure.

143. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the tubular sleeve further comprises a sealing element coupled to the exterior surface of the tubular sleeve.

144. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the tubular sleeve is metallic.

145. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; wherein the tubular sleeve is non-metallic.

146. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; wherein the tubular sleeve is plastic.

147. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; wherein the tubular sleeve is ceramic.

148. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; wherein the tubular sleeve is frangible.

149. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member; wherein the tubular sleeve comprises one or more longitudinal slots.

150. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the tubular sleeve comprises one or more radial passages.

151. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the first and second tubular members are amorphously bonded.

152. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the first and second tubular members are welded.

153. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member;

wherein the internal threads of the first tubular member and the internal threads of the second tubular member together provide a fluid tight seal.